ABSTRACT
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Long Term Life Testing of a Mechanically Pumped Cooling Loop For Spacecraft Thermal Control

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Spacecraft thermal control design is traditionally based on passive elements that help in maintaining the spacecraft temperatures within their required limits. The passive thermal hardware include various type of surface finishes and paints, multilayer insulation, thermostatically controlled heaters, radiators, mechanical louvers, and conduction control elements. Heat pipes have been used increasingly in the last fifteen years to both enhance and control heat transfer between spacecraft components.

Mechanically pumped single phase cooling loops have been used extensively for ground and aircraft applications. They have also been used in space for short durations such as in the space shuttle. These loops can provide enormous flexibility and robustness to the thermal design of the spacecraft. They eliminate some of the limitations posed by heat pipes or capillary pumped loops in relation to testing and integration of the spacecraft, However, these kind of loops have not been used for long duration space applications lasting months or longer. The main reason is the lack of heritage of the mechanical pumps for long duration missions.

For the Mars Pathfinder spacecraft a mechanically pumped cooling loop was designed, fabricated and tested as part of the thermal control system. Pathfinder will be launched during December 1996. The flight duration requirement for the loop is 7 months of uninterrupted operation. Since the functioning of this loop is crucial to the success of the mission, and since there was no heritage on such a system for a long duration, it was decided in the early stage of the design to develop a life test set-uj> which will be run indefinitely (at least for a duration longer than the flight). Because of the schedule constraints, the life test was run in parallel with the design and integration of the flight system to gain valuable insight and experience related to the functioning of such a system.

Since the life test was going on in parallel with the flight system design and fabrication, some of the information gathered during this life test has already been incorporated into the flight system, other information gathered will be used for future missions, The life test has already clocked more than a year of successful operation.

It simulate.s the pump assembly, particle filter, accumulator, check valves, Aluminum and Stainless Steel tubing, Teflon flex lines, etc. The long term synergistic compatibility of all these materials is being tested along with the change in the performance of the system, e.g., the change in the flow rate, pressure rise, and pumping power as a function of time. Also being verified arc the potential for any long term leaks from several mechanical joints used to integrate the system.

This paper will discuss the design of the cooling loop, the performance of the life test, the lessons learned, and the design and operation changes made to the flight cooling loop as a result of this life test. Recommendations for improvement of future loops based cm the experience gained in this life test will also be made.